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(71) Applicant: EXXON CHEMICAL PATENTS INC. [US/US]; 1900 East Linden Avenue, Linden, NJ 07036-0710 (US).

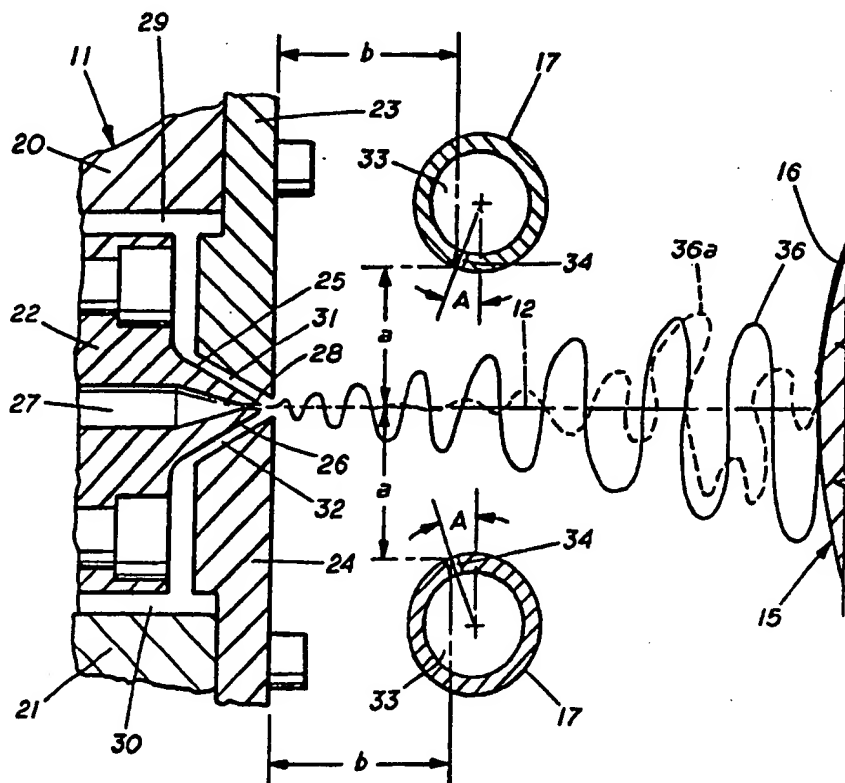
(72) Inventors: BUNTIN, Robert, Robson ; 201 Post Oak, Baytown, TX 77520 (US). MILLIGAN, Mancil, Wood ; Rt 1, Box 195B, Luttrell, TN 37779 (US). LU, Fumin ; 1611 Laurel Avenue, Apt. No. 1309, Knoxville, TN 37916 (US).

(74) Agents: GRAHAM, Robert, L.; Graham & Graham, 15603 Kuykendahl, Suite 115, Houston, TX 77090 (US) et al.

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(54) Title: METHOD AND APPARATUS FOR TREATING MELTBLOWN FILAMENTS



(57) Abstract

A meltblowing die (11) is provided with means for discharging crossflow air (17) onto meltblown filaments (36) to disrupt their shape and flow pattern between the die and the collector (16). The disruption enhances drag forces imparted by the primary meltblowing air and results in smaller diameter filaments.

-1-

METHOD AND APPARATUS FOR TREATING MELTBLOWN FILAMENTS

1 This invention relates generally to the preparation of
meltblown filaments and webs. In one aspect the invention relates
to a method of manufacturing meltblown webs having improved
strength.

5 Meltblowing is a one step process in which a molten
thermoplastic resin is extruded through a row of orifices to form
a plurality of polymer filaments (or fibers) while converging sheets
of high velocity hot air (primary air) stretch and attenuate the
hot filaments. The filaments are blown unto collector screen or
10 conveyor where they are entangled and collected forming a nonwoven
web. The converging sheets of hot air impart drag forces on the
polymer strands emerging from the die causing them to elongate
forming micro-sized filaments (typically 0.5-20 microns in diameter).
Secondary air is aspirated into the filament/air stream to cool and
15 quench the filaments.

The meltblown webs have unique properties which make
them suitable for a variety of uses such as filters, battery
separators, oil wipes, cable wraps, capacitor paper, disposable
liners, protective garments, etc. One of the deficiencies,
20 however, of the meltblown webs, is their relatively low tensile
strength. One reason for the low tensile strength is the fact
that the filaments have only moderate strength. Although the
primary air draws down the filaments, tests have shown that the
polymer molecular orientation resulting therefrom is not retained.
25 Another reason for low strength is the brittle nature of the
filaments when collected close to the die (e.g. less than 18").
Another deficiency for many applications is a relatively broad
distribution of filament sizes within a single web.

Efforts have been made to alter the properties of the
30 web by treating the filaments between the die and the collector,
but none have been directed primarily at increasing the strength
of the web. For example, in accordance with U.S. Patent No.
3,959,421, a liquid spray has been applied to filaments near the
die discharge to rapidly quench the filaments for the purpose of

- 2 -

1 improving the web quality (e.g. reduction in the formation of
"shot"). Also, cooling water was employed in the process described
in U.S. Patent No. 4,594,202 to prevent fiber bonding. U.S.
Patent No. 4,904,174 discloses a method for applying electrostatic
5 charges to the filaments by creating an electric field through
which the extruded filaments pass. U.S. Patent 3,806,289 discloses
a meltblowing die provided with a coanda-nozzle for depositing
fibers onto a surface in a wavy pattern.

SUMMARY OF THE INVENTION

10 It has been discovered that by disrupting the flow of
the hot polymeric filaments discharged from a meltblowing die, the
drawdown of the filaments can be increased. The increased draw-
down results in several improved properties of the meltblown web
or mat, including improved web strength, improved filament
15 strength, more uniform filament diameter, and softer, less brittle
web.

In accordance with the present invention the extruded
filaments between the meltblowing die and the collector screen
(or substrate) are contacted with crossflow air of sufficient
20 intensity to disrupt the natural flow shape of the filaments.
The crossflow air causes the filaments to assume an undulating or
flapping flow behavior beginning near the die discharge and
extending to the collector.

Tests have shown that the undulating or flapping flow
25 behavior results in significantly increased drawdown of the
filament. ("Drawdown" as used herein means the ratio of the
emerging filament diameter at the die tip to final diameter.)

Although the reasons for the improved results have not
been fully developed, it is believed that the disruption of the
30 filament flow in a region near the die discharge creates a con-
dition for improved drag of the primary air on the filaments. In
the normal filament flow (without crossflow air) the primary air
flow is substantially parallel to filament flow, particularly near
the die discharge. However by creating undulations in the fila-
35 ment flow near the die discharge, portions of the filament are

- 3 -

1 positioned crosswise of the primary air flow thereby increasing the effects of drag thereon.

For clarity of description, the crossflow medium is referred to as "air" but other gases can be used. The water spray
5 techniques disclosed in U.S. Patents 3,959,421 and 4,594,202 does not sufficiently disrupt the filaments to achieve the desired results. It should also be noted that the coanda discharge nozzle cannot be used as taught in U.S. Patent No. 3,806,289 because such an arrangement would not result in increased drawdown but merely
10 pulses the filaments to one side of the coanda nozzle in providing a wavy deposition pattern of the fibers on the collecting surface.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of a meltblowing apparatus capable of carrying out the method of the present
15 invention.

Figure 2 is a side elevation of meltblowing die, illustrating schematically the flow shape of the filaments with and without crossflow air.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

20 As mentioned previously, the present invention relates to the application of crossflow air onto the row of filaments discharging from a meltblowing die. A meltblowing line with crossflow air chambers is illustrated in Figure 1 as comprising an extruder 10 for delivering molten resin to a meltblowing die 11
25 which extrudes molten polymer strands into converging hot air streams forming filaments. (12 indicates generally the center lines of filaments discharged from the die 11). The filament/air stream is directed onto a collector drum or screen 15 where the filaments are collected in a random entanglement forming a web 16. The web
30 16 is withdrawn from the collector 15 and may be rolled for transport and storage.

The meltblowing line also includes heating elements 14 mounted in the die 11 and an air source connected to the die 11 through valved lines 13.

- 4 -

1 In accordance with the present invention, the meltblowing line is provided with air conduits 17 positioned above and/or below the row of filaments 12 discharging from the die 11. As will be described in more detail below, each conduit 17 has a
5 longitudinal slot for directing air onto the filaments 12. (The term "filament" as used herein includes both continuous strands and discontinuous fibers.)

 As shown in Figure 2, the meltblowing die 11 includes body members 20 and 21, an elongate nosepiece 22 secured to the
10 die body 20 and air plates 23 and 24. The nosepiece 22 has a converging die tip section 25 of triangular cross section terminating at tip 26. A central elongate passage 27 is formed in the nosepiece 22 and a plurality of side-by-side orifices 28 are drilled in the tip 26. The orifices generally are between 100
15 and 1200 microns in diameter.

 The air plates 23 and 24 with the body members 20 and 21 define air passages 29 and 30. The air plates 23 and 24 have tapered inwardly facing surfaces which in combination with the tapered surfaces of the nosepiece 25 define converging air
20 passages 31 and 32. As illustrated, the flow area of each air passage 31 and 32 is adjustable. Molten polymer is delivered from the extruder 10 through the die passages (not shown) to passage 27, and extruded as a micro-sized, side-by-side filaments from the orifices 28. Primary air is delivered from an air source
25 via lines 13 through the air passages and is discharged onto opposite sides of the molten filaments as converging sheets of hot air. The converging sheets of hot air are directed to draw or attenuate the filaments in the direction of filament discharge from the orifices 28. The orientation of the orifices (i.e. their
30 axes) determine the direction of filament discharge. The included angle between converging surfaces of the nosepiece 25 ranges from about 45 to 90°. It is important to observe that the above description of the meltblowing line is by way of illustration only. Other meltblowing lines may be used in combination with the
35 crossflow air facilities described below.

- 5 -

1 The air conduits 17 may be tubular in construction
having both ends closed defining an internal chamber 33. Each
conduit 17 has at least one slot 34 formed therein. The slot 34
extends parallel to the axis of the conduit 17 and traverses the
5 full row of orifices 28 in the die 11. The slot 34 of each
conduit 17 is sized to provide air discharge velocities sufficiently high to contact the filaments. Velocities of at least 20
fps and between 300 and 1200 fps are preferred. Slots having a
width of between .010 to 0.040 inches should be satisfactory for
10 most applications. Flow rates through each slot of 20 to 300 SCFM
per inch of orifice length (e.g. length of die tip 25) are preferred. The air delivery lines 18 may be connected at the
ends of the conduits 17 as illustrated in Figure 1 or may connect
to a midsection to provide more uniform flow through the
15 conduits 17. The air is delivered to the conduits at any pressure
but low pressure air (less than 50 psi) is preferred. The
conduits may be of other shapes and construction and may have more
than one slot. For example, a conduit of square, rectangular, or
semicircular cross section may be provided with one, two, or three
20 or more parallel slots. The cross sectional flow area of each
conduit may vary within a wide range, with 0.5 to 6 square inches
being preferred and 0.75 to 3.5 square inches most preferred.

The conduits 17 may be mounted on a frame (not shown) to permit the following adjustments:

- 25 vertical ("a" direction in Figure 2)
 horizontal ("b" direction in Figure 2)
 angular (angle "A" in Figure 2)

The angle A is the orientation of the longitudinal axis of the slot with reference to the vertical. A positive angle A
30 (+A°) indicates the slot 34 is positioned to discharge air in a
direction away from the die and thereby provide an air velocity
component transverse or crosswise of the filament flow and a
velocity component in the same direction as the primary air flow.
A negative angle A (-A°), on the other hand, indicates the slot
35 34 is positioned to discharge air toward the die to provide an air

- 6 -

1 velocity component transverse or crosswise the filament flow and a
 velocity component opposite the flow of the primary air. A zero
 angle A, of course, indicates the slot is positioned to discharge
 air at right angles to the direction of filament discharge (e.g.
 5 to the direction of orientation of the orifices 28). The
 reference to horizontal and vertical are merely for purposes of
 description. The relative dimensions a, b, and A will apply in
 any orientation of the extrusion die 11.

As mentioned previously, the main function of the
 10 crossflow air discharging from the slots 34 is to disrupt and alter
 the natural flow pattern or shape of the filaments discharging
 from the die 11. It is preferred that the cross flow air contact
 the filaments as close to the die 11 as possible (i.e. within 1/4
 the distance between the die 11 and the collector 15) and still
 15 provide for a generally uniform filament flow to the collector 15.
 Optimally, the crossflow air should disrupt the filaments within
 1", preferably within 1/2", and most preferably within 1/4" from
 the orifices. The conduits 17 are mounted, preferably, one above
 and one below the filament/air, having the following positions.

	<u>Broad Range</u>	<u>Preferred Range</u>	<u>Best Mode</u>
a	1/8 to 2 1/2"	1/8 to 1 1/2"	1/8 to 1/4"
b	0 to 8"	0 to 5"	0 to 1/2"
A	-40° to 70°	-35 to 45	-20 to 10

25 The two conduits 17 may be positioned symmetrically on
 each side of the filament/air stream or may be independently
 operated or adjusted. Thus, the apparatus may include one or two
 conduits

Figure 2 illustrates the flow pattern of a filament 36a
 30 without the use of the crossflow conduits 17. As illustrated the
 filament 36 flows in a relatively straight line for a short
 distance (in the order of 1 inch) after discharge from the
 orifices 28 due to the drag forces exerted by the primary air flow.

- 7 -

1 At about 1 inch from the die, the filament 36a flow shape begins to undulate reaching a region of violent flapping motion after about 3 to 6 inches. This flapping motion is believed to result in increased drawdown of the filament 36a.

5 The onset and behavior of the flapping motion is dependent on several factors including die slot width, nosepiece design, set back, operating temperatures, primary air flow rate, and polymer flow rate. Because so many variables are involved, it is not believed possible to control these variables with a high
10 degree of certainty to achieve a desired amount of filament flapping. It appears to be an inherent behavior for a particular set of parameters. It is known, however, that in the initial region, the primary air flow is generally parallel to the filament flow so little or no flapping occurs in this region.

15 In accordance with the present invention, crossflow air is impinged on the filaments to initiate the onset of filament crosswise or flapping flow shape much closer to the die outlet. This earlier onset of flapping filament flow increases drawdown because the filament assumes an attitude crosswise of the primary
20 air flow permitting a more efficient transfer of forces by the primary air flow. Moreover, the filaments are hotter and may even be in the molten or semimolten state during the early stages of the flapping flow behavior.

Using air conduits 17 to deliver cross flow air where a
25 was 1/2", b was 1", and angle A was 0°, the filament 36 had the flow behavior, also depicted in Figure 2. The crossflow air disrupted the filament flow almost immediately upon leaving the die 11 and is characterized by a larger region of high amplitude wave motion and much longer flapping region. Tests have shown
30 that the induced flapping motion of the filament in accordance with the present invention decreases filament diameter significantly over conventional meltblowing (without crossflow air) under the same operating conditions. It is preferred that the crossflow air produced diameter decreases in the order of 10 to 70%, most
35 preferably in the order of 15 to 60%. The resultant increased in

- 8 -

1 polymer orientation increases the filament strength and the web strength. Tests indicate that the filaments have a more uniform size (diameter) distribution and the collected webs are stronger and tougher.

5 Operation

In carrying out the method of the present invention, the conduits 17 are placed over and/or under the die outlet and adjusted to the desired "a", "b", and angle "A" settings. The meltblowing line is operated to achieve steady state operations.
10 The crossflow air then is delivered to the conduits 17 by a conventional compressor at the desired pressure. Some minor adjustments may be necessary to achieve optimum results.

It is important to note that the air conduits may be added to on any meltblowing die. For example, the die 11 may
15 be as disclosed in U.S. Patent 4,818,463 or U.S. Patent 3,978,185, the disclosures of which are incorporated herein by reference.

Thermoplastic materials suitable for the process of the invention include polyolefins such as ethylene and propylene homopolymers, copolymers, terpolymers, etc. Suitable materials
20 include polyesters such as poly(methylmethacrylate) and poly(ethylene terephthate). Also suitable are polyamides such as poly(hexamethylene adipamide), poly(omega-caproamide), and poly(hexamethylene sebacamide). Also suitable are polyvinyls such as polystyrene and ethylene acrylates including ethylene acrylic
25 copolymers. The polyolefins are preferred. These include homopolymers and copolymers of the families of polypropylenes, polyethylenes, and other, higher polyolefins. The polyethylenes include LDPE, HDPE, LLDPE, and very low density polyethylene. Blends of the above thermoplastics may also be used. Any
30 thermoplastic polymer capable of being spun into fine fibers by meltblowing may be used.

A broad range of process conditions may be used according to the process of the invention depending upon thermoplastic material chosen and the type of web/product
35 properties needed. Any operating temperature of the thermoplastic

- 9 -

1 material is acceptable so long as the materials is extruded from
the die so as to form a nonwoven product. An acceptable range of
temperature for the thermoplastic material in the die, and
consequently the approximate temperature of the diehead around the
5 material is 350°-900°F. A preferred range is 400°-750°F. For
polypropylene, a highly preferred range is 400°-650°F.

Any operating temperature of the air is acceptable so
long as it permits production of useable non-woven product. An
acceptable range is 350°-900°F.

10 The flow rates of thermoplastic and primary air may vary
greatly depending on the thermoplastic material extruded, the
distance of the die from the collector (typically 6 to 18 inches),
and the temperatures employed. An acceptable range of the ratio
of pounds of primary air to pounds of polymer is about 20-500,
15 more commonly 30 - 100 for polypropylene. Typical polymer flow
rates vary from about 0.3 - 5.0 grams/hole/minute, preferably
about 0.3-1.5.

EXPERIMENTS

Experiments were carried out using a one-inch extruder
20 with a standard polypropylene screw and a die having the following
description:

	no. of orifices	1
	orifice size (d)	0.015 inches
	nosepiece included angle	60°
25	orifice land length	0.12 inches
	Air slots (defined by air plates)	2 mm opening and 2 mm neg. set back

Other test equipment used in Series I Experiments
30 included an air conduit semi-circular in shape and having one
longitudinal slot formed in the flat side thereof. The air
conduits in the other Experiments were in the form of slotted
pipes 1 inch in diameter.

Series I Experiments

35 The resin and operating conditions were as follows:

- 10 -

1 Resin: 800 MFR PP (EXXON Grade 3495G)
 Die Temp.: 430°F
 Melt Temp.: 430°F
 Primary Air Temp.: 460°F
 5 Primary Air Rate: 16.5 SCFM per in. of die width
 Polymer Rate: 0.8 gms/min.
 Slot opening: 0.030 in.
 Web collector: screen 12 inches from the die

The a, b, and angle A values for the tests of this series were 1", 1 1/2", and +30°, respectively. The data are shown in Table I.

Table 1

TEST NO.	CONDITION	CROSS-FLOW		AVG. Z-TENA-		DIAMETER ² MICRONS	DIA. STD. DEVIATION
		AIR ³ CHAMBER PRESS.	BASIS WEIGHT GM/M2	TYPE OF CITY ¹ Web	mN/TEX		
15	1-1 Base Case	0	44.30	Brittle	10.5	7.93	2.93
	1-2 "	0	41.77	"			
20	2-1 Crossflow Device In Place	0	39.90	"	15.6	7.57	2.80
	2-2 "	0	37.30	"	13.5		
	3-1 "+ Secondary Air Taped Off	0	40.80	"	13.4	8.33	3.67
25	3-2 "	0	40.80	"	12.4		
	4-1 Crossflow Device In Place	5	37.30	Tough, Soft	19.4	6.59	2.20
	4-2 "	5	37.30	"	17.7		
	5-1 "	14	33.80	"	22.3	6.52	1.87
30	5-2 "	14	33.80	"	16.8		
	6-1 "+ Secondary Air Taped Off	14	31.60	"	19.3	6.87	2.18
	6-2 "	14	37.30	"	17.8		
	7-1 "	5	32.90	"	19.6	7.65	2.26
35	7-2 "	5	32.30	"	17.7		

- 11 -

- 1 1Z-TENACITY was measured by cutting 1" wide strips and testing in an Instron tensile tester with zero separation between jaws. Jaw separation speed was 1.0 in/min.
- 2Average fiber diameter was measured by optical microscope with
5 an overall magnification of 400. The microscope was focused on a sample of the web and every fiber within the view area was measured using a reticulated ocular. Several different focus areas were selected at random to give a total fiber count of 50. The average reported is a simple number average of all
10 fiber measurements for each sample.
- 3The air velocities for 5 and 14 psi were 705 fps and 1030 fps, respectively.

The Table I data demonstrate that the crossflow air resulted in the following

- 15 (a) The diameter of the filaments was decreased.
(b) The filament diameter distribution was more uniform.
(c) The web strength was improved.
(d) The quality of the web was improved.

20 Series II Experiments:

These tests employed the same line and polymer but with one tubular air conduits permitting adjustment of the a, b, and angle A settings. Table 2 presents the data for Series II Experiments.

- 12 -

1

Table 2

5	TEST	SETTINGS		CROSSFLOW ¹	AVG.	STD.
		a	b	CHAMBER PRESSURE	FIBER DIAM.	
	NO.			psi	A	DEVIATION
	1	-	-	-	-	10.85
	2	1/2"	1/2"	2	-35°	8.48
10	3	"	"	4	"	7.06
	4	"	"	8	"	8.72
	5	3/8"	5/8"	2	-20°	6.36
	6	"	"	4	"	6.17
	7	"	"	8	"	8.16
15	8	1/4"	7/8"	2	0°	8.6
	9	"	"	4	"	7.65
	10	"	"	8	"	9.58
	11	3/8"	1"	2	20°	9.0
	12	"	"	4	"	8.96
20	13	"	"	8	"	9.22
	14	1/2"	5/4"	2	45°	9.22
	15	"	"	4	"	8.66
	16	"	"	8	"	8.47

25 ¹Air velocities at 2, 4, 6, and 8 psi were 476 fps, 654 fps, 761 fps, and 859 fps, respectively.

30 These data indicate that for all a, b, and A settings the filament avg. diameters were reduced and the size distributions were decreased. The 0 to negative angle settings (0 to -35°) gave the best results and are therefore preferred. Table 2 data indicates that the optimum crossflow chamber pressure or velocity depend on the geometry.

1 Series III Experiments:

These tests employed only one crossflow conduit (under the filament discharge) having a, b, and A settings of 3/8", 5/8", and -20, respectively. The primary air flow rate (at a temp. of 530°) was varied and the die and melt temperatures were 500°. The other conditions were the same as in Series I and II tests. The data for Series III tests are shown in Table 3.

Table 3

10	TEST NO.	PRIMARY AIR RATE (SCFM*)	CROSSFLOW CHAMBER PRESSURE	AVERAGE FILAMENT DIAMETER	STD. DEVIATION
			psi		
	1	11	-	8.77	3.33
	2	18	-	5.07	2.56
15	3	27	-	3.77	2.22
	4	18	2	2.83	1.11
	5	18	4	3.16	1.06
	6	18	6	3.72	1.33
	7	27	2	2.7	1.36
20	8	27	4	2.4	0.89
	9	27	8	3.58	1.44

*per inch of die width

Test Runs 1-3 in this table show the effect on fiber diameter by increasing primary air rate with no crossflow air used. The use of crossflow air gives a significant reduction in diameter and diameter standard deviation at both low and high primary air rates. Again, an optimum crossflow air rate was observed. Highest crossflow air (8 spi) produced larger diameter filaments than medium crossflow air (4 psi), although still smaller than for the 0 crossflow air base case.

Best results appear to be obtained at crossflow velocities between 476 fps (2 psi) and 859 fps (8 psi). Tests have shown that chamber pressure as low as 1 psi can produce improved results.

- 14 -

1 Series IV Experiments:

These tests were conducted with two crossflow conduits illustrated in Figure 2. Each conduit was adjusted independently of the other to provide different crossflow contact areas. The upper conduit had a, b, and A settings of 1/2", 3/4", and +30°, respectively; and the lower conduit had a, b, and A settings of 1/2", 1", and -20°, respectively. The data for Series III Experiments are presented in Table 4.

Table 4

TEST NO.	CROSSFLOW CHAMBER PRESSURE		AVG. FIBER DIAMETER	STD. DEVIATION	
	PSI		<u>DIAMETER</u>	<u>DEVIATION</u>	
	upper	lower			
15	1	0	0	5.69	2.58
	2	0	2	3.45	1.19
	3	2	2	3.9	1.53
	4	6	2	3.23	1.0
	5	4	4	3.95	1.58
20	6	8	4	3.64	1.37

These data indicate that the settings of the upper and lower conduits can be varied and still provide improved results. It is significant to note that Test No. 2 using only the lower conduit gave better results than all but one of the other Series IV Experiments.

In summary, the method of the present invention may be viewed as a two stage air treatment of extruded filaments: the primary air contacts the filaments at an angle of between about 22° to about 45° to impart drag forces on the filaments in the direction of filament extrusion, the crossflow air contacts the extruded filaments at a point down stream of the contact point of the primary air and at a contact angle of at least 10° greater than the contact angle of the primary air on the same side of plane 12 to impart undulating flow shape to the extruded filaments. As viewed in Figure 2 the contact angle of the primary air is

- 15 -

1 determined by the center line of the passages 31 and 32 with plane
12. The contact angle of the crossflow air from conduit 17 above
plane 12 (defined by the focus of slot 34 and plane 12) is at
least 10° larger than the contact angle of the primary air from
5 passage 31 as measured clockwise. Likewise, the contact angle of
crossflow air from the conduit 17 below the plane 12 is at least
10° larger than the contact angle of the primary air from passage
32 as measured counterclockwise in Figure 2. The crossflow air
has a major velocity component perpendicular to the direction of
10 filament extrusion and a minor velocity component parallel to the
direction of filament extrusion.

- 16 -

CLAIMS:

1. In a meltblowing method comprising extruding a polymer melt through a plurality of parallel orifices arranged in a row to form a plurality of filaments, contacting the extruded filaments with sheets of air converging from opposite sides of the row of filaments to impart drag forces on the filaments forming a filament/air stream, and depositing the filaments on a collector or substrate, the improvement comprising contacting the filaments in the filament/air stream with crossflow air to disrupt the normal flow shape of the filaments, the crossflow air being of sufficient velocity and rate to create or increase undulations in the flow shape of the filaments thereby increasing the drawdown of the filaments and decreasing the average diameter of the filaments by at least 10% over that attainable without the crossflow air under the same operating conditions.
2. The method of claim 1 wherein the step of contacting the filaments with the crossflow air is carried out by directing air flow onto the extruded filaments in a region between the orifice discharge and $1/4$ the distance between the orifice discharge and the collector or substrate, the crossflow air flow being perpendicular to, or having a major velocity component perpendicular to, the axes of the orifices and a minor velocity component toward or away from the direction of filament discharge.
3. The method of claim 1 wherein the orifices of the meltblowing die have centerlines which lie in the same plane, and the crossflow air is in the form of a sheet, the direction of which forms an angle with said plane, said angle ranging from +45 degrees to -35 degrees with respect to the vertical where (+)

- 17 -

indicates an angle away from the orifices and (-) indicates an angle toward the orifices.

4. The method of claim 1 wherein the crossflow air disrupts the normal flow patterns of the filaments within 1 inch from the discharge of the orifices.

5. The method of claim 1 wherein the crossflow air has a flow rate of between 20 to 300 SCFM per inch of the row of orifices and a velocity of between 200 to 1200 fps.

6. The method of claim 1 wherein the direction of the crossflow air has a major velocity component perpendicular to the direction of filament extrusion and a minor velocity component parallel to the direction of filament discharge.

7. The method of claim 1 wherein the orifices have a diameter between 100 to 1200 microns and the filaments deposited on the collector or substrate have a diameter of between 0.5 to 20 microns.

8. The method of claim 1 wherein the crossflow air disrupts the flow of the filaments within a region beginning within 1/2 inch of the orifice discharge.

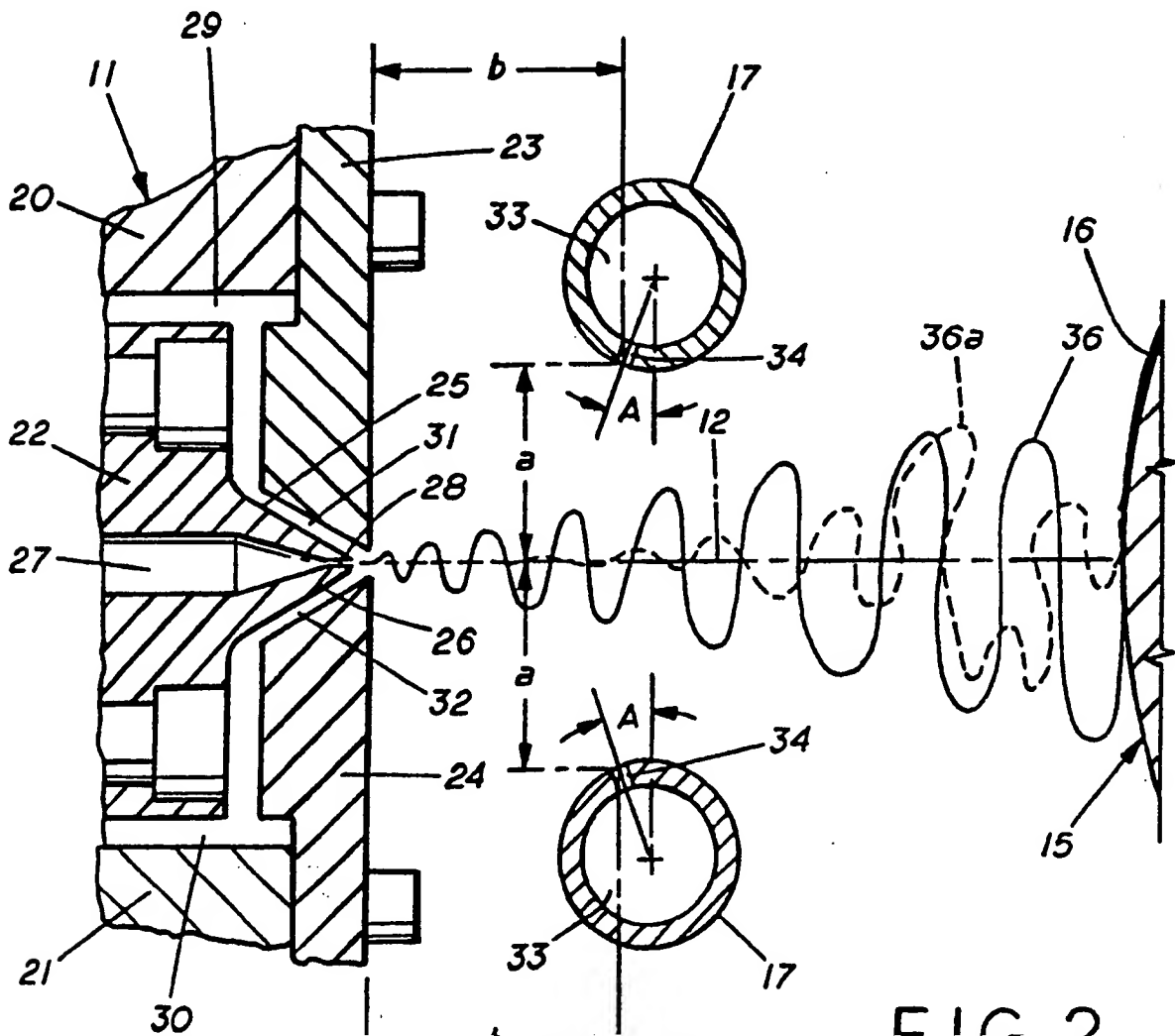
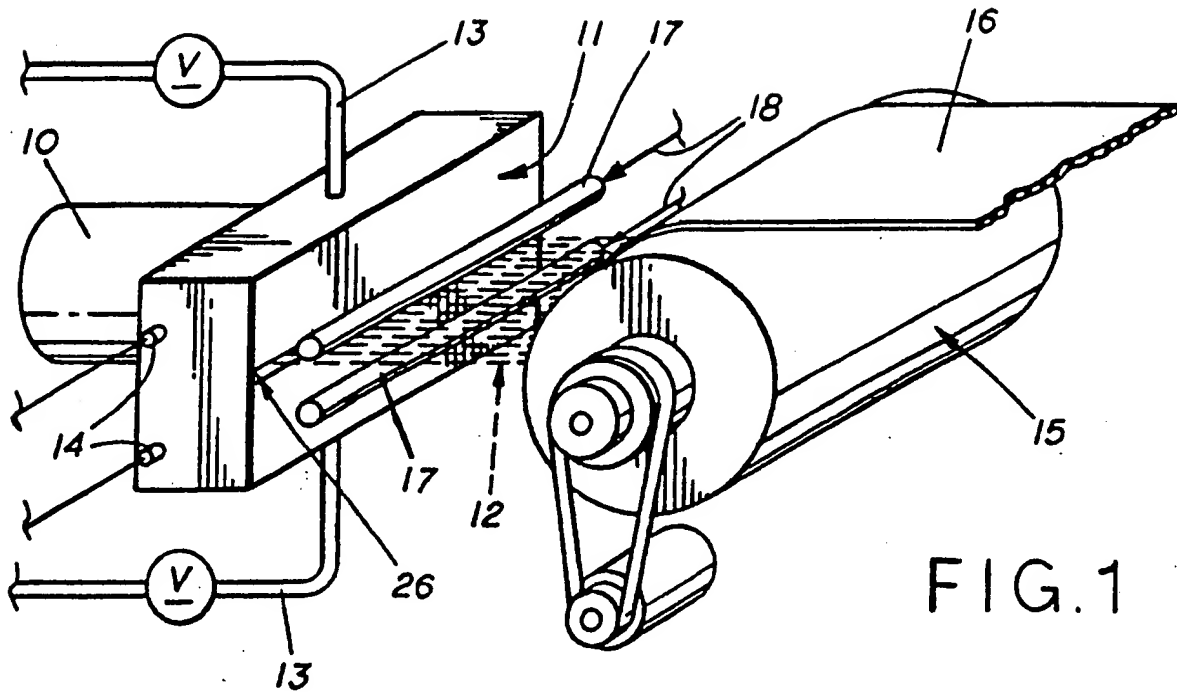
9. The method of claim 1 wherein the step of contacting the filaments with crossflow air is carried out by directing crossflow air from a source position down on one side of the filaments/air stream.

- 18 -

10. In a meltblowing method comprising extruding a polymer melt through a plurality of parallel orifices arranged in a row to form a plurality of filaments, contacting the extruded filaments with sheets of air converging from opposite sides of the row of filaments to impart drag forces on the filaments forming a filament/air stream, and depositing the filaments on a collector or substrate, the improvement comprising contacting the filaments in the filament/air stream with crossflow air to disrupt the normal flow shape of the filaments, the crossflow air being continuous and at the same rate and being of sufficient velocity and rate to create or increase undulations in the filaments flow shape thereby increasing the drawdown of the filaments.

11. In a meltblowing method comprising extruding a polymer melt through a plurality of parallel orifices arranged in a row to form a plurality of filaments, contacting the extruded filaments with sheets of air converging from opposite sides of the row of filaments to impart drag forces on the filaments forming a filament/air stream, and depositing the filaments on a collector or substrate, the improvement comprising contacting the filaments in the filament/air stream with crossflow air to disrupt the normal flow shape of the filaments, the crossflow air being of sufficient velocity and rate to create or increase undulations in the filaments flow shape thereby increasing the drawdown of the filaments, the direction of said crossflow air being at least 10 degrees greater than the angle of the converging air sheet on the same side of the row of orifices.

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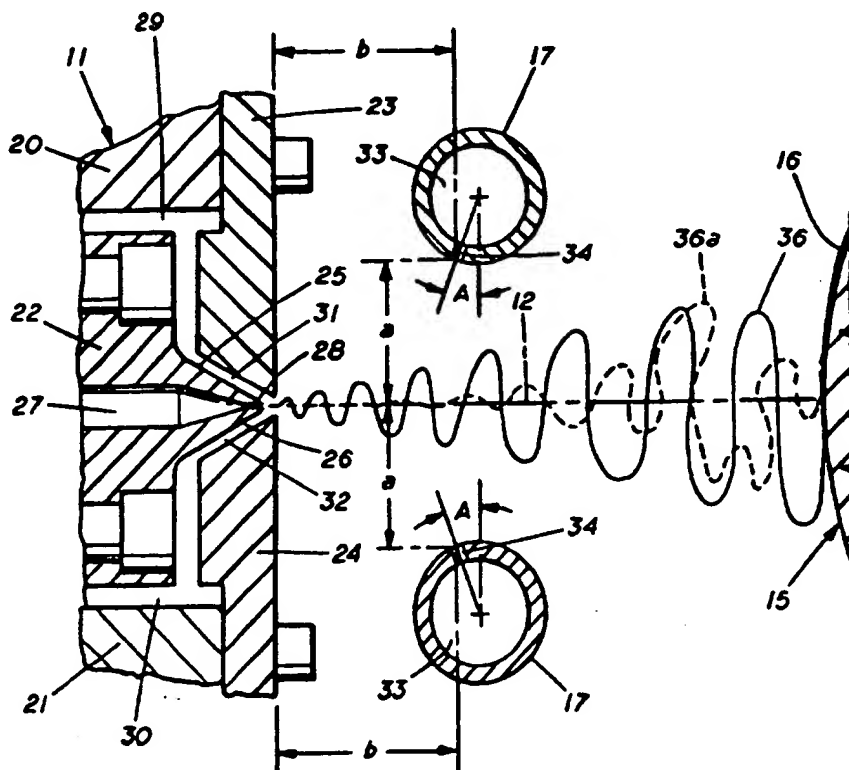




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<p>(21) International Application Number: PCT/US91/07377 (22) International Filing Date: 3 October 1991 (03.10.91) (30) Priority data: 596,057 11 October 1990 (11.10.90) US (71) Applicant: EXXON CHEMICAL PATENTS INC. [US/ US]; 1900 East Linden Avenue, Linden, NJ 07036-0710 (US). (72) Inventors: BUNTIN, Robert, Robson ; 201 Post Oak, Bay- town, TX 77520 (US). MILLIGAN, Mancil, Wood ; Rt 1, Box 195B, Luttrell, TN 37779 (US). LU, Fumin ; 1611 Laurel Avenue, Apt. No. 1309, Knoxville, TN 37916 (US).</p>		<p>(74) Agents: GRAHAM, Robert, L.; Graham & Graham, 15603 Kuykendahl, Suite 115, Houston, TX 77090 (US) et al. (81) Designated States: AT (European patent), BE (European patent), CA, CH (European patent), DE (European pa- tent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), GR (Eur- pean patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent). Published <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p>

(54) Title: METHOD AND APPARATUS FOR TREATING MELTBLOWN FILAMENTS



(57) Abstract

A meltblowing die (11) is provided with means for discharging crossflow air (17) onto meltblown filaments (36) to disrupt their shape and flow pattern between the die and the collector (16). The disruption enhances drag forces imparted by the primary